Original Article

A continuous quality improvement project to reduce medication error in the emergency department

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BACKGROUND: Medication errors are a common source of adverse healthcare incidents particularly in the emergency department (ED) that has a number of factors that make it prone to medication errors. This project aims to reduce medication errors and improve the health and economic outcomes of clinical care in Hong Kong ED.

METHODS: In 2009, a task group was formed to identify problems that potentially endanger medication safety and developed strategies to eliminate these problems.

RESULTS: Responsible officers were assigned to look after seven error-prone areas. Strategies were proposed, discussed, endorsed and promulgated to eliminate the problems identified. A reduction of medication incidents (MI) from 16 to 6 was achieved before and after the improvement work.

CONCLUSION: This project successfully established a concrete organizational structure to safeguard error-prone areas of medication safety in a sustainable manner.

KEY WORDS: Medication error; Medication safety; Continuous Quality Improvement (CQI)

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INTRODUCTION

Medication errors are a common cause of adverse healthcare incidents that impact on the quality of care. Medication errors may account up to one-third of all medical errors in hospital.[1] Of course, not all medication errors lead to morbidity or mortality but the relatively high incidence makes it a problem still worth dealing with. The emergency department (ED) is at the front line of preventing medication error and the first we need to do is to raise our awareness of the problem and choose strategies to eliminate the error and mitigate harm if errors do occur.[2]

This project aims to reduce medication errors and improve the health and economic outcomes of clinical care in the ED through a continuous quality improvement (CQI) cycle.

METHODS

This project began in the third quarter of 2009 and went on until the end of year 2011. A task group was formed to identify problems and develop strategies to reduce medication error. This task group was composed of staff from multiple professional groups and grades including emergency specialists, resident trainees, nursing officers and registered nurses. There were three phases to the project:

Phase 1 (problem identification)

A. Seven error-prone areas: 1) drug allergy; 2) charting of medication administration record (MAR); 3) high risk medication; 4) intravenous devices & infusion; 5) look-alike sound-alike (LASA) drugs; 6) drug storage & replenishment and; and 7) prescription practice under computerized medication order entry (MOE).

B. Intricate medication item lists.

Phase 2 (problem elimination)

A. Assign members of the task group to review the 7 error-prone areas;

B. Streamline different medication item lists to

eradicate duplicated and seldom used items;

C. Elimination of medications that may be inadvertently administered;

D. Standardization of practice;

E. To apply critical redundancies to medications that may be inadvertently administered;

F. To apply concept of medication safety to ED renovation; and

G. Extension of working hours of hospital pharmacy.

Phase 3 (assure sustainability)

To conduct regular audit; and to establish checking and review system.

RESULTS

Specific members of the task group were assigned to review each of the seven error-prone areas. They were encouraged to suggest error prevention strategies for subsequent discussion and implementation. The existing four medication items lists were reorganized to only three lists through absorption of a number of drug items from the overnight list to others. Duplicated, seldom prescribed or items generically identical but with multiple strengths (for example, paracetamol suppository 125 mg versus 250 mg; warfarin tablet 1 mg versus 2 mg) were streamlined, leading to a reduction of drug items number from 181 to 166.

The storage of high-risk medications and intravenous fluids with potassium supplement were had been centralized and listed (Table 1). Independent double-checking was required for all routes of administration of high-risk medications and intravenous infusions (IVI). The use of infusion pump was mandatory for the administration of intravenous fluids with potassium supplements. Medications that may be inadvertently administered, including heparin and concentrated electrolytes, were removed from the ED stocks.

Alert labels were attached to the documents of patients who had known drug allergies. Eye-catching labels were stuck to locations where there were high-risk medications and medications commonly associated with allergy. Look-alike-sound-alike (LASA) medications were identified with improved differentiation which was achieved by re-arranging storage sites and addition of tall letter alphabets, for example, AmPIcillin versus AmOXYcillin and AmloDIPINE AmiodaRONE. We standardized the regimen of commonly prescribed intravenous fluid infusions (Table 2) to eliminate variation. Models of intravenous syringe and infusion pumps were also standardized and other models were kept as back up devices.

The ED renovation started in the first quarter of 2011 with elements of medication safety that had been incorporated into our renovation plan so as to avoid unnecessary secondary storage within clinical area and potential public access to medications. Locations of secondary drug storage were minimized from four to one. Lastly, the risk of ED dispensing was greatly reduced after the working hours of the hospital pharmacy were extended from 8 to 14 hours. As a consequence, stock of pre-packed medication items were re-estimated and optimized to fit in the new ED nursing station.

With respect to the hospital authority advanced

Table 1. High-risk medication list

	Drug items	DDA cabinet	Cub.10 fridge	NS1 fridge	R1 fridge	E-Trolleys	Top-up cupboard	Observation room	RX room
1.	Muscle relaxants Rocuronium/Cisatracurium/Suxamethonium		√	√ (E kit)	√				
2.	Actrapid HIV		√						
3.	Adrenaline 1:1 000		√		√				
4.	Vasopressors Adrenaline 1:10 000/Vasopressin					√			
5.	Inotropes Dopamine/Dobutamine					√			
6.	Digoxin					√			
7.	$MgSO_4$					√			
8.	Thrombolytics Streptokinase/Metalyes	√							
9.	Lignocaine 1%						√		√
10.	Penicillin group antibiotics						√	√	
11.	Warfarin						√	√	
12.	Aspirin & NSAID						√	√	
13.	Oral Hypoglycaemics						√	√	

Table 2. Standardized chart for IVI dilution regimen

Medication	Strength (may vary)	Dose to be added	Type of diluent/ to a total volume	Conc	Description /Rate	Dose	Dose	Dose	Dose	Dose	Formula	Dosage Remarks
Adrenaline 1:1 000 (Epinephrine)	1 mg /mL	3 mg	+ NS or D5 to total vol.50 mL	60 mg/ mL	N mg/min	5	10	15	20	25	N	5–50 mg/min
					(mL/h)	5 mL	10 mL	15 mL	20 mL	25 mL	(1.0 N) mL	
Aminophylline	250 mg /10 mL	250 mg	+ NS or D5 to total vol.50 mL	5 mg/ mL	N mg/h	15	30	40	50	60	N	15–60 mg/h
					(mL/h)	3 mL	6 mL	8 mL	10 mL	12 mL	(N÷5) mL	
Amiodarone (Cordarone)					Refer to infusion pump chart							
Diltiazem (Herbesser)	50 mg (powder) +5 mL NS or D5	50 mg	+NS or D5 to total vol.50 mL	1 mg/ mL	N mg/kg/min	5	7.5	10	12.5	15	N	5–15 mg/kg/min
					kg*	mL/hr*	mL/hr*	mL/hr*	mL/hr*	mL/hr*	mL/hr	
					41–50 kg	14 mL	20 mL	27 mL	34 mL	41 mL	(2.7 N) mL	
					51–60 kg	17 mL	25 mL	33 mL	41 mL	50 mL	(3.3 N) mL	
					61–70 kg	20 mL	29 mL	39 mL	49 mL	59 mL	(3.9 N) mL	
					71–80 kg	23 mL	34 mL	45 mL	56 mL	68 mL	(4.5 N) mL	
					81–90 kg	26 mL	38 mL	51 mL	64 mL	77 mL	(5.1 N) mL	
Dobutamine (Dobutrex)	250 mg /20 mL	250 mg	+NS or D5 to total vol.50 mL	5 mg/ mL	N mg/kg/min	1.25	2.5	5	7.5	10	N	1–10 mg/kg/min Starting dose 2.5–5 mg/kg/min (Infusion rate is rounded up to integer)
					kg*	mL/hr*	mL/hr*	mL/hr*	mL/hr*	mL/hr*	mL/hr	
					31–40 kg	1 mL	1 mL	2 mL	3 mL	4 mL	(0.42 N) mL	
					41–50 kg	1 mL	1 mL	3 mL	4 mL	5 mL	(0.54 N) mL	
					51–60 kg	1 mL	2 mL	3 mL	5 mL	7 mL	(0.66 N) mL	
					61–70 kg	1 mL	2 mL	4 mL	6 mL	8 mL	(0.78 N) mL	
					71–80 kg	1 mL	2 mL	5 mL	7 mL	9 mL	(0.90 N) mL	
					81–90 kg	1 mL	3 mL	5 mL	8 mL	10 mL	(1.02 N) mL	
					91–100 kg	1 mL	3 mL	6 mL	9 mL	11 mL	(1.14 N) mL	
Dopamine (Dopaminex)	200 mg /5 mL	200 mg	+NS or D5 to total vol.50 mL	4 mg/ mL	N mg/kg/min	1.25	2.5	5	7.5	10	N	1–10 mg/kg/min Starting dose 2.5–5 mg/kg/min (Infusion rate is rounded up to integer)
					kg*	mL/hr*	mL/hr*	mL/hr*	mL/hr*	mL/hr*	mL/hr	
					31–40 kg	1 mL	1 mL	3 mL	4 mL	5 mL	(0.53 N) mL	
					41–50 kg	1 mL	2 mL	3 mL	5 mL	7 mL	(0.68 N) mL	
					51–60 kg	1 mL	2 mL	4 mL	6 mL	8 mL	(0.83 N) mL	
					61–70 kg	1 mL	2 mL	5 mL	7 mL	10 mL	(0.98 N) mL	
					71–80 kg	1 mL	3 mL	6 mL	8 mL	11 mL	(1.13 N) mL	
					81–90 kg	2 mL	3 mL	6 mL	10 mL	13 mL	(1.28 N) mL	
					91–100 kg	2 mL	4 mL	7 mL	11 mL	14 mL	(1.43 N) mL	

incidents reporting system (AIRS), there was 16 medication incidents (MI) of our department between 2008 and 2010 and was dropped to 6 only from 2011 till now with a comparable number of attendances.

DISCUSSION

Many factors contribute ED to making the ED a hotbed of medication errors. These include multiple patients being treated concurrently, frequent reliance on verbal orders, a wide range of high-risk medications, a variety of administration routes, time pressures, ED dispensing and interruption and distractions.[3] In addition, the ED is also expected to manage complex error-prone procedures involving drug administration, for example, administration of thrombolytic agents and conscious sedation drugs. Other factors associated with medication errors include lower triaged level patients, time of day (more errors during weekend and night shifts[4]) and LASA drugs.

Medication use is a complicated process and benefits from simplification and regular review. Traditionally, the ED in Hong Kong has intricate medication item lists: 1) top-up; 2i) GF277 (drug items that available as pre-packed); 3) basket item lists (mainly intravenous fluids and topical treatment), and even leftover drugs. These lists containing items that sometimes are overlapped, sometimes are seldom used, and sometimes are of a high-risk nature. Storage of dangerous drugs and high-risk medications should be centralized for safety, regardless of healthcare providers' inconvenience, enabling a working environment with minimal distraction.[2,5]

There are five stages of drug ordering and delivery in the ED: 1) prescription; 2) transcription; 3) dispensing; 4) administration; and 5) monitoring. Each of these stages represents a vulnerable link in a chain along which any variety of errors can occur. The two most common factors associated with prescribing errors are lack of knowledge about the drug prescribed and lack of knowledge regarding the patient for whom the drug is prescribed.[6] The best way to eliminate error arising

from this stage is to achieve standardization of complex medication processes such as standardization of IVI dilution regimen of high-risk medications.[5]

Transcription errors refer to communication breakdowns between prescribing clinicians and dispensing staff. In the ED, this is most commonly caused by a verbal medication order being misheard. In order to prevent such error, it is essential to implement a protocol on verbal ordering of drugs and takes steps to include "read-back" verification, documentation and retrospective signing.

The stage of dispensing medications is the last chance to correct a medication error for patients who are being discharged from the ED making use of critical redundancies.[5,6] Dispensing nurses have to confirm the patient's allergy status, verify weight and perform independent double-checking on dispensing high-risk medications and medications to error-prone populations especially children. Pediatric patients pose a unique set of challenges to emergency physicians and nurses for two reasons: 1) most medications prescribed and administered to pediatric patients are weight-based doses; and 2) some medications are contra-indicated in children younger or older than a certain age.[5] One of the particularly challenging factors involving children is that they come in all sizes. This, coupled with the need for weight-based dosing, makes arithmetic errors a common occurrence.[7] High-risk population groups also include the elderly, trauma patients and patients with diminished renal function.

Administration errors happen when either the wrong drug is administered or the right drug is administered in the wrong dose or via the wrong route. Safety checklists may help to eliminate this type of error and staffs are encouraged to stick to the 3 checks (prescription, drug and patient) 5 rights (time, drug, dose, route and patient) principle.

In conclusion, the unique milieu of the ED bears a number of factors that may exacerbate medication error rates and severity. This project established a concrete organizational structure to safeguard key areas of medication safety in a sustainable manner.

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